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## 276

Show that the attraction of a finite mass on one of its points is finite.

[*A. Hall.*]

SOLUTION.

Take the origin at the point attracted, and let  $k \, dx \, dy \, dz$  be the element of mass,  $V$  the potential for a particle of the body, and  $r$  the distance of the particle from the origin. We have

$$V = \iiint \frac{k \, dx \, dy \, dz}{r}.$$

Put

$$x = r \cos u, \quad y = r \sin u \cos \lambda, \quad z = r \sin u \sin \lambda;$$

then

$$dx \, dy \, dz = r^2 \sin u \, du \, d\lambda \, dr,$$

and

$$V = \iiint k r \sin u \, du \, d\lambda \, dr.$$

The limits of integration are  $u = 0$ , to  $u = \pi$ ;  $\lambda = 0$ , to  $\lambda = 2\pi$ ; and  $r = 0$ , to the limits of the body. For the component of the force in the axis of  $x$  we have

$$X = \frac{\partial V}{\partial x} = \iiint \frac{k x \, dx \, dy \, dz}{r^3} = \iiint k \cos u \sin u \, du \, d\lambda \, dr,$$

with similar values for  $Y$  and  $Z$ . These components are finite, and therefore the resultant is finite. See Gauss, *Allgemeine Lehrsätze, etc.*

[*A. Hall.*]

## EXERCISES.

## 306

A body at distance  $r$  from the sun is moving with velocity  $v$ . Prove that the major axis of the orbit described is parallel to the direction of motion if, and only if, the velocity is "circular velocity for the distance  $r$ ."

[*Ellery W. Davis.*]

## 307

If a horizontal beam of length  $2a$  is supported at each end, and has a load in the form of an isosceles triangle, base  $2a$ , height  $b$ , a unit's thickness throughout, and heaviness unity; show that the deflection of the beam due to this triangular load is  $\frac{2a^4 b}{15EI}$ .

[*T. U. Taylor.*]